Water Storage Task Force

Report to the Legislature

February 2001

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

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Water Storage Task Force

Report to the Legislature

Prepared by
Water Resources Program
Washington State Department of Ecology
under the direction of
The Water Storage Task Force

Cover photo: Judy Reservoir, Skagit County

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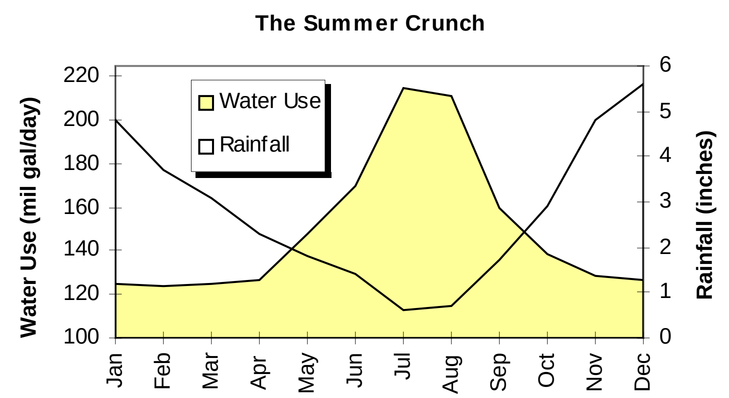
The Need for Storage

Compared to many of the western states, the state of Washington would seem to have plenty of water. This water, however, is not distributed evenly across the state, nor is it available at all times of the year. Differences in climate result in an annual precipitation of over 200 inches on the coast, and less than eight inches in some areas of Eastern Washington. Furthermore, most of our precipitation comes in the late fall and winter, when demand is lowest. In the summer, when precipitation and stream flows are at their lowest, the demand for water is at its highest. Figure 1 illustrates the seasonal changes in rainfall and municipal water use in the Seattle area.



This chart shows that water availability and water use are mirror images. Water use is highest when water availability is lowest, creating a summer water supply "crunch."

FIGURE 1. *Source:* Seattle Public Utilities 1998 Accomplishment Report

The demand for water in Washington is increasing. A growing state population, a healthy economy and declines in salmon populations have each created a call for increased water supplies. These supplies are not readily available in many parts of the state, especially during the dry season. Today, approximately 350 lakes and streams in Washington are closed to further withdrawals of water. Approximately 100 more streams are partially closed, and 200 streams have stream flows set by rule. The needs for water have sharpened the competition for available supplies and have added a new urgency to the need to secure additional water supplies.

Growth and economic development have been stalled in cities and counties that don't have access to additional water. The cities of Battle Ground, North Bend, Lynden, Granger, Warden, Cle Elum, Tieton, and East Spokane are among the many communities searching for more water.

Rural economic development is also stifled by lack of water. Farmers in the Tucannon River and Pataha Creek drainages have asked for more water in an area that already doesn't have enough water to serve current requests. In Snohomish County, a large, new organic farm was recently told it could not get a new water right, as the area does not have enough water for current uses.

In many parts of the state, fish are at risk of becoming extinct, in part because they don't have enough water. There are many streams where flows are considered to be too low for fish in the summer and fall. This problem exists in streams on both sides of the Cascades and is an issue in most of the counties of the state. In addition, as we look to the future, climate models by the University of Washington indicate the potential for even less snow pack and lower summer flows over the next decade or two.

One solution for the state's water supply problem is to store water when there is excess runoff and stream flows, and deliver or release it during the low-flow period when it is needed for people and fish.

Task Force: Purpose and Process

During the 2000 legislative session, the Legislature recognized the potential for additional water storage as a solution to the water supply needs of the state. As a result, the following proviso was included in the 2000 supplemental operating budget (Chapter 1, Laws of 2000, Engrossed House Bill 2487):

> *Section 301(27). $150,000 of the general fund state appropriation for fiscal year 2001 is provided solely for creating the task force on water storage.* ***The purpose of the task force is to examine the role of increased water storage in providing water supplies to meet the needs of fish, population growth, and economic development, and to enhance the protection of people's lives and their property and the protection of aquatic habitat through flood control facilities.*** *For this purpose, increased storage may be in the form of surface storage including off-stream storage, underground storage, or the enlargement or enhancement of existing structures. The task force shall also examine means of providing funding for increased water storage.*
>
> *The department of ecology shall provide staff support for the task force and the director of the department of ecology shall convene the first meeting of the task force not less than thirty days after the effective date of this section.*
>
> *No member of the task force shall receive compensation, per diem, or reimbursement of expenses from the task force or the department of ecology for his or her activities as a member of the task force. However, each may receive such compensation, per diem, and/or reimbursement as is authorized by the entity he or she is employed by, is appointed from, or represents on the task force.*
>
> *Following its examination, the task force shall report its recommendations to the appropriate committees of the legislature by December 31, 2000.* (emphasis added)

In response to this proviso, Ecology invited agencies, organizations and individuals with a range of interests in water storage to provide representatives to serve on a Water Storage Task Force. From this invitation process, the following individuals were nominated to serve:

Bob Alberts, Pasco Public Works Department, representing WA Water Utility Council and Association of Washington Cities
John Bowman, Lakehaven Utility District
Dueane Calvin, City of Yakima
Walt Canter, Washington Association of Water and Sewer Districts
Representative Gary Chandler, House Agriculture & Ecology Committee
Lee Faulconer, Department of Agriculture
Tom Fitzsimmons, Department of Ecology, Water Storage Task Force Chairman
Senator Karen Fraser, Senate Environmental Quality & Water Resources Committee
Steve George, Hops Growers of Washington

Max Golladay, Kittitas County Commissioner, representing Washington Association of Counties, Eastern Washington
Jim Hazen, Washington State Horticultural Association
Representative Kelli Linville, House Agriculture & Ecology Committee
Ken Lisk, Washington State Water Resources Association
John Mankowski, Washington Department of Fish and Wildlife
Senator Bob Morton, Senate Environmental Quality & Water Resources Committee
Bob Pancoast, East King Co. Regional Water Association, representing Washington Water Utility Council, Western Washington
Tom Ring, for Harris Teo, Jr., Yakama Nation
Mike Schwisow, Washington State Water Resources Association
Dave Somers, Snohomish County Commissioner, representing Washington Association of Counties, Western Washington
Ginny Stern, Washington Department of Health
Judy Turpin, Washington Environmental Council

Five all-day meetings of the task force were held. Press releases were issued prior to each meeting, and the public and media were invited to attend and observe meetings. The schedule and locations of the meetings were as follows:

1.	August 1, 2000	Hyak Lodge at Snoqualmie Pass
2.	September 11, 2000	Mount Vernon, Skagit PUD offices
3.	October 5, 2000	Ellensburg, Hal Holmes Conference Center
4.	November 9, 2000	Bellevue, Ecology's Northwest Regional Office
5.	December 7, 2000	Lacey, U.S. Fish and Wildlife Service

The first two meetings were organized by Ecology staff to provide information to the task force on issues surrounding storage. Presentations were made by task force members, outside parties and Ecology staff having expertise in various water issues. Appendix A contains summaries for the presentations given during the initial meetings. Ecology also presented a draft outline for the task force report at the second meeting.

Meeting 3 largely involved discussing the issues, previous presentations and contents of the report. The task force began forming conclusions and recommendations during this meeting. Detailed discussion and editing of each recommendation was done during Meeting 4. The recommendations were reviewed, and the conclusions were discussed and completed during Meeting 5.

Reasons for Storing Water

Water can be stored to serve many different purposes, including supplies for domestic needs, municipal uses, agricultural irrigation, and fish and wildlife needs. Water storage also helps control floods, generate power and serve recreational needs. Many of the state's existing storage projects serve more than one purpose. The most common combinations for larger projects in Washington are:

- Irrigation, recreation and wildlife.
- Hydropower generation and flood control.

Increasing demand and decreasing natural storage are the major reasons for the call for increased water storage in this state.

Increasing demand

State population has grown from 1.5 million to over 5 million in the last 80 years, and is estimated to reach 7 million by the year 2010.

- <u>Population growth</u> increases the need for domestic water supplies, commercial and industrial water supplies, power generation and food production.

- <u>Fish populations</u> are in decline in a number of streams and rivers. All but one county in the state has a salmon, trout and/or steelhead species with a current Endangered Species Act designation. ESA listings have spurred the call for increased stream flows to assist in the recovery of these species.

Decreasing natural storage

Water stored under ground and water in the form of snow represent the largest sources of stored water in the state: "natural storage." This naturally stored water is often the only source of stream flows during the late summer and early fall, as the snow melts and the ground releases water to maintain surface streams. Underground water (also called ground water) is also the only source of water for many communities around the state.

- <u>Loss of ground-water recharge</u>. Urbanization that creates larger areas with impervious surfaces will divert storm flows and decrease ground-water recharge. Development that narrows the floodplain will reduce the recharge of ground water that would normally occur during routine flooding.

- <u>Climate change</u>. Most scientists agree that the earth is warming, either from natural causes and/or increased greenhouse-gas emissions from human activity. A small increase in temperature would result in less snow and an earlier melt, reducing the natural storage benefits of the snow pack and producing higher flows in the spring and lower flows in the late summer. A small increase in temperature will also raise the freezing level. Some areas that currently have a snow pack may no longer have any snow after the winter months.

Methods for Storing Water

Storing water can be done in several ways. Water can be stored above ground in a surface-water reservoir, usually behind a dam. Water can also be stored underground in aquifer storage and recovery sites.

Surface Water Reservoirs

- The most common method for storing water is creating a surface reservoir behind some sort of dam or dike.

- There are currently more than 1,100 dams in Washington State that store more than 10 acre-feet, with about 380 dams used primarily for water supply storage. However, most projects are rather small, and only 80 dams are greater than 50 feet in height.

- On-channel dams and reservoirs are sited on major streams and are filled directly by flow from the upstream watershed. These are typically large projects that impound many thousands of acre-feet of water.

- Off-channel dams are sited outside the main river valley, on an intermittent stream or completely off-stream. There is typically minimal inflow provided by the tributary drainage. Water to fill the reservoir is usually diverted by gravity or pumping from a much larger adjacent basin.

- New dams can be built to create new water reservoirs, or existing reservoirs can be enlarged by raising existing dams.

Aquifer Storage and Recovery

- Aquifer storage and recovery is defined as capturing usable excess water and storing it underground for later use.

- Potential sources of water for underground storage include excess surface water in winter, stormwater runoff, and high-quality, treated/reclaimed water.

- Methods for getting water into aquifer storage include direct injection via wells, surface spreading by irrigation or use of ponds, and infiltration by piping the water just beneath the land surface.

- Recovering the stored water is typically done by using wells. Under the right conditions, aquifer recharge can also be done to help recover base flows for a nearby stream, spring, or wetland.

- Unlike surface reservoirs, aquifer storage does not require significant commitment or changes in use of the land surface.

- Aquifer storage may restore declining water levels due to over-withdrawals from the aquifer.

- Aquifer storage has the potential to improve water quality of native underground water.

- Aquifer storage requires locating an aquifer in a geologic formation where most of the water will stay in place long enough for it to be recovered.

- Reclaimed water shows promise as a source of “new” water for storage in underground reservoirs, but there remain public perception issues with potential contamination of ground waters.

The major benefits and drawbacks of these water storage methods are outlined in Table 1.

Table 1: Comparison of Different Methods of Storage

New On-Channel Dams	
Benefits	***Drawbacks***
• Large reservoirs can be filled by direct runoff from the drainage basin using the stream as the conveyance system. • Can provide substantial flood control benefit. • Usually less expensive construction, operations and maintenance costs than for large off-channel reservoirs.	• Can requires relocation of people and infrastructure. • Can drown significant riparian habitat. • Barrier to fish passage. • Sediment load can eventually fill in reservoir. • Requires large spillways and outlet works.
New Off-Channel Dams	
• Generally do not represent a barrier to fish passage. • Can be sited in a non-environmentally sensitive area, and may not require extensive mitigation. • Less water quality harm on main river than for on-channel dams • Much smaller spillways and outlet works needed.	• Require extensive conveyance infrastructure (canals, pipes) to get water into and out of reservoir. • Construction, operations and maintenance costs can be much higher than on-channel reservoirs. • Leakage and seepage may require a liner to be placed in the reservoir.
Raise Existing Dams	
• New environmental effects are relatively fewer and smaller compared to a new dam. • The unit cost for increased water storage is typically much lower than for new dam projects. • Significant storage volume can typically be added for a relatively small increase in dam height.	• Existing development around the reservoir has to be relocated or purchased. • Potential risk to downstream lives and property increased, may require extensive dam safety upgrading. • Wetlands and riparian habitats created by the existing reservoir may be displaced.
Aquifer Storage & Recovery	
• Minimal construction is required. • Reduced land surface effects. • Little or no loss of environmental habitat. • No evaporation losses. • Better protection from surface contaminants. • Potential improvements in water quality, streamflow and aquifer levels.	• Limited technical, management and regulatory experience with this storage method. • Possible contamination of existing groundwater by introduced water. • Ownership and/or management of lands over the aquifer may be required similar to Wellhead Protection Areas. • Favorable geology required to limit aquifer leakage.

Water Storage in Washington

Early residents in Washington recognized that the water supply from natural stream flows was limited in the summer months, especially in Eastern Washington. Numerous small dams and reservoirs were built in the late 19th and early 20th centuries to store water from the spring runoff to release water later in the summer to meet the specific needs of irrigation, stock watering and cities.

The first major storage dam project in Washington was the 68-foot-high Nine Mile Dam on the Spokane River, built by the Washington Water Power Company in 1908 for power generation. The first significant irrigation reservoir was the 70-foot-high Conconully Dam and Reservoir, built by the U.S. Reclamation Service in 1910 for the Okanogan Project. In 1914, Seattle built the 215-foot-high Masonry Dam on the Cedar River to provide drinking water for the growing city. In addition to the water supply dams, the U.S. Army Corps of Engineers built several large flood-control dams in the 1940s, including the 350-foot-high Mud Mountain Dam on the White River.

In the ensuing years, dozens of major dam and storage reservoir projects were built for hydropower, irrigation, flood control and municipal supply. Today, there are more than 1,100 dams in Washington, including 80 dams greater than 50 feet in height. A map showing the locations of all dams in the state is shown in Figure 2. A breakdown of the purposes of the larger dams (greater than 50 feet high) is shown in Figure 3.

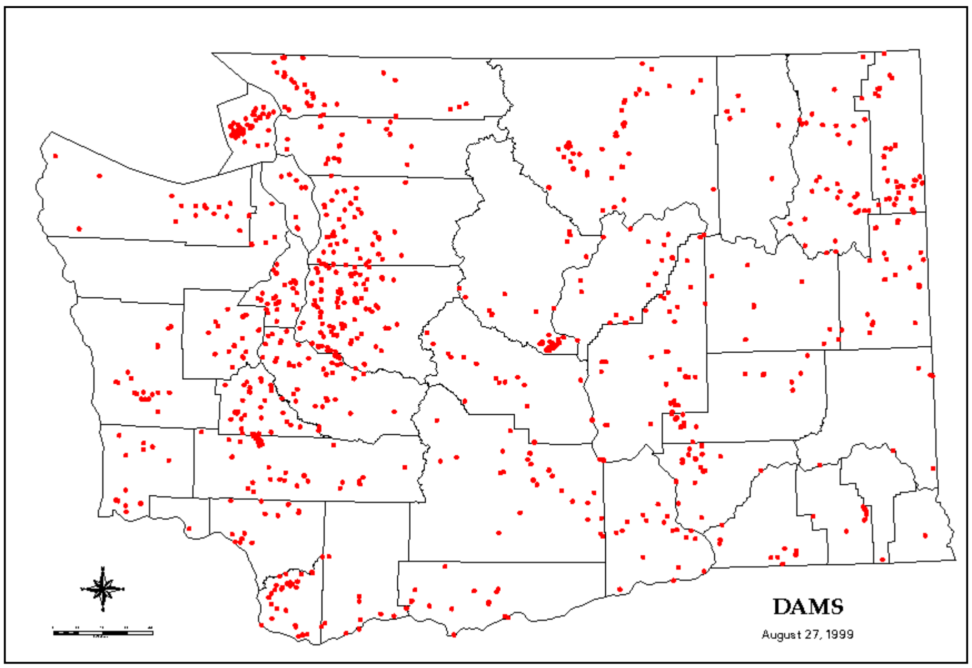
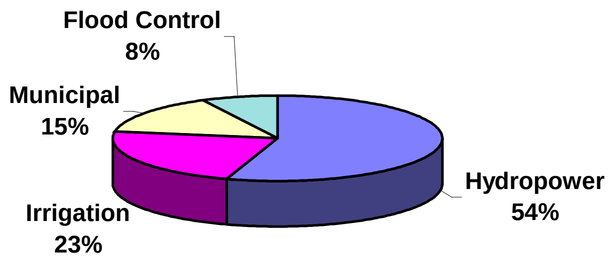


Figure 2: Location of Dams in Washington State

Figure 3.

Primary Purposes of Water Storage Dams Greater than 50 Feet High in Washington



Storage in Surface Reservoirs

Hydropower Reservoirs

The majority of large dams in Washington have been built for hydropower uses. A total of 44 large dams have been built, primarily on major rivers. The projects have been built by a variety of entities, including cities, public utility districts, and private utilities. While these dams store a large quantity of water, their primary purpose is non-consumptive generation of power, with some flood control provided as a secondary benefit. For the most part, these projects do not supply a significant quantity of water for consumptive uses, such as municipal supply or irrigation.

Examples of major dams and reservoirs that are primarily used for hydropower include:
- Ross, Diablo and Gorge dams on the Skagit River, owned by Seattle City Light
- Mossyrock and Mayfield dams on the Cowlitz River, owned by Tacoma Public Utilities
- Upper and Lower Baker dams on the Baker River, owned by Puget Sound Energy
- Nine Mile and Long Lake dams on the Spokane River, owned by Avista Corporation

Irrigation Reservoirs

While numerous irrigation reservoirs have been built in Washington by various individuals and agencies, the primary builder and owner of the largest projects is the U.S. Bureau of Reclamation (USBR). The USBR designed and constructed 12 large dams for storage reservoirs in Washington between 1910 and 1985. The largest of the state dams by far is Grand Coulee Dam, which stands 380 feet high and holds over 9.5 million acre-feet of water. Grand Coulee Dam is a multipurpose facility, used for hydropower, flood control and irrigation. The dam cost $1.85 billion in 1998 dollars to construct between 1935 and 1943 *(World Commission on Dams Case Studies: Grand Coulee Dam and Columbia Basin Project, USA, March 2000)*.

This dam is the cornerstone of the Columbia Basin Project, which uses a total of nine dams impounding five major and two minor reservoirs to distribute water to more than 550,000 acres of irrigated farmland in the Columbia Basin. The Columbia Basin dams were built between 1935 and 1962. The overall cost of the Columbia Basin Project (excluding Grand Coulee Dam) was $3.6 billion in 1998 dollars.

Municipal Water Supply Reservoirs

Numerous dams and reservoirs have been built for cities and towns since the early 1900s to meet their water supply and distribution system requirements. Most of the large dams with major reservoirs are located along the west slopes of the Cascade Mountains, serving the large cities in the Puget Sound area. These projects were designed to capture some of the winter and spring runoff from rainfall and snowmelt and hold it until needed in the dry summer and early fall months.

The largest projects include:

- Masonry/Chester Morse Reservoir dams and South Fork Tolt River Dam for the city of Seattle
- Casad Dam/Union River Reservoir for the city of Bremerton
- George Culmback Dam/Spada Lake for Snohomish County and the city of Everett

Many cities and counties also use smaller, off-stream reservoirs for storage and/or flow regulation, such as Seattle's Lake Youngs Reservoir, Everett's Lake Chaplain Reservoir, or the Skagit PUD No.1's Judy Reservoir project. The case study on Judy Reservoir is included in Appendix B. Many of these dams have been altered multiple times to increase storage to meet the needs of a growing population.

Flood Control Reservoirs

Most dams in Washington built to store water for flood control have been relatively small, stormwater-detention-type dams that serve small watersheds. However, the U.S. Army Corps of Engineers has built six large dams in the state solely for flood control. The first large flood control dam, Mill Creek Dam, was constructed in 1942 to reduce flooding in Walla Walla. This dam and reservoir is located off-channel in an adjoining drainage, and stores excess flows from Mill Creek via a diversion channel. The largest single-purpose flood-control dam in Washington is Mud Mountain Dam, a 350-foot-high structure constructed by the Corps in 1948 on the White River.

In addition to these single-purpose reservoirs, the Corps works with owners of hydropower and water supply dams throughout Washington to manage them in the winter to reduce the effects of large floods. The capability to store water for flood control is limited on these projects, because flood control operation (requiring that the reservoir be kept empty before the storm season) conflicts with the primary uses of the reservoir for water supply and/or hydropower.

Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) involves storing water via pumping or infiltration in an underground aquifer and recovering it through wells when needed. This technology has been around for some time and is extensively used in other states, including Oregon, but to date has seen limited use in Washington. One of the first significant ASR projects is the OASIS project in Federal Way, proposed by the Lakehaven Utility District. Planning for this project began in 1989 and would store up to 29,000 acre-feet of water. Another significant ASR project has been proposed by the city of Walla Walla, involving storing water in aquifers that have declined as a result of prior use.

Recent Reservoir Storage Projects

Although construction of new large dams and reservoirs slowed considerably in the latter part of the last century, there have been some notable projects constructed in Washington in the last 15 years. Table 2 provides listings and selected details on several of these projects.

Table 2: Recent Water Storage Projects Constructed in Washington

Project Name	County	River or Stream	Year Built	Dam Height (ft)	Storage (ac-ft)	Const. Cost	Purpose(s)
IRRIGATION							
French Canyon Reservoir	Yakima	N.F. Cowiche Creek	1985	56	670	$7.7 million*	Reregulation
Rosa Wasteway 6 Reregulation Reservoir	Yakima	Offstream	1988	18	65	$863,000	Reregulation
Rosa Wasteway 7 Reregulation Reservoir	Yakima		1991	15	15	$403,000	Reregulation
Wenatchee Heights Reservoir No. 2	Wenatchee	Stemilt Creek	1996	30	80	$241,000	Irrigation Supply
FLOOD CONTROL							
Zintel Canyon Dam	Benton	Zintel Canyon	1992	97	2300	$3.9 million	Flood Control
HYDROPOWER							
Cowlitz Falls Dam	Lewis	Cowlitz River	1993	120	10,000	??	Hydropower
MUNICIPAL SUPPLY							
Indian Creek Reservoir	Pacific	Bear River	1989	74	846	$2.3 million*	Municipal
Judy Reservoir Enlargement	Skagit	Offstream	2000	10 foot raise	1700 added	$9 million	Municipal
OASIS Underground Storage Pilot Project	King	Underground	1992	N/A	29,000 potential	$60-70 million ?	Municipal

* Year 2000 dollars

Policies Related to Storage

This section summarizes policies related to storage. Policies contained in government programs related to land management that may affect siting of new storage projects are also mentioned.

State Policies

Washington statutes contain several general policy statements related to water storage. The few key guiding principles related to storage are described below:

- Long-range development goals of the state include furnishing an adequate supply of water for domestic, industrial, agricultural purposes, municipal, fishery, recreational, and other beneficial uses. (RCW 43.83B.010; RCW 43.99E.010)

- It is in the public interest to encourage the impoundment of excess water in basins where there is water available on a seasonal basis that is in excess of the needs of streams or existing water-rights holders. Both storage and other alternatives should be encouraged. The goal is to strengthen the economy and improve the state's environment. (RCW 90.03.255)

- It is state policy to obtain maximum net benefits and support economically feasible and environmentally sound development of physical facilities for diversion and storage. (RCW 90.03.005)

- Storage that serves multiple purposes is preferred over single-purpose storage (RCW 90.54.020)

- In determining the cost-effectiveness of alternative water sources, full consideration should be given to benefits of storage. (RCW 90.54.180(4))

- Agencies are to help applicants seek a safe and reliable water source. Assistance can include creation of interties, storage, and conservation. (RCW 43.21A.064(5))

Detailed citations of state law related to storage, including agency authorities, planning, water rights, permits, and funding are provided in Appendix C.

Federal Policies

Some federal agencies have policies related to managing water, land and other natural resources that would be applicable to water storage projects. Some of these policies will affect any proposed storage project, while other policies will only affect storage projects proposed on federal lands.

The National Marine Fisheries Service (NMFS) has no formal, written policy concerning water storage. Storage projects are reviewed on a case-by-case basis. In general, the stated NMFS policy is to support activities if benefits for fish outweigh the disadvantages (personal communication, Mike Grady, 2000).

The U.S. Forest Service has a written Aquatic Conservation Strategy. The strategy was developed to restore and maintain the ecological health of watersheds and their related aquatic ecosystems. The strategy applies to federal lands managed by the Forest Service and Bureau of Land Management within the range of Pacific Ocean anadromous fish populations. The strategy does not directly address storage projects on federal lands, but its effect is to identify and prioritize certain land for the purpose of watershed restoration and to ensure that proposed activities on federal lands not interfere with the restoration objectives. A copy of the complete Strategy is in Appendix D.

While neither the U.S. Bureau of Reclamation nor the U.S. Army Corps of Engineers has any formal policies on water storage, both agencies have been responsible for planning, constructing and operating a number of the larger structures in the western U.S. These structures serve mostly irrigation, hydropower and flood-control purposes.

Tribal Policies

Some tribal governments have enacted water laws and adopted rules and programs related to managing water and land within their jurisdictions. Neither of the tribes involved with the Storage Task Force has written policies specifically related to storage. As independent governments, water and land-management policies will vary between different tribes.

Planning Considerations

State law provides several planning processes that directly relate to water storage.

Public water system plans

Public water systems are required to prepare water system plans for review and approval by the Washington Department of Health. All systems are required to prepare an initial plan. Larger systems and systems that are expanding need to prepare updates to these plans every six years.

Water system plans are required to include detailed evaluations of future water demand and to demonstrate adequate availability of water supplies to meet that demand. Water storage is routinely evaluated during development of these plans. Smaller storage units are a routine feature of many public water system plans. Some systems also rely heavily on their basin-level storage sites, and water system plans are often the origin of proposed new storage projects.

Watershed plans (2514)

In 1998, the state Legislature passed the Watershed Management Act to provide a framework for local citizens, interest groups and governmental organizations to collaboratively identify and solve water-related issues in each of the state's 62 Water Resource Inventory Areas (WRIAs). Two-thirds of the WRIAs in this state are currently involved in planning under the Act, and many of the watershed plans called for under the act will be prepared and adopted in the next few years.

One step in this planning process involves an assessment of the watershed, including a description of water supplies, uses and needs. The resulting watershed plan must include strategies for meeting future needs, both in-stream and out-of-stream. Water storage is expected to be a major feature of many of these watershed plans.

Land-use plans

Washington cities and towns have had land-use plans for years. Under the Growth Management Act (GMA), many local governments are required to plan for financing and delivering services needed to meet planned growth, including water supplies. Where growth is projected to occur in areas with limited existing water supplies, water storage can be an important tool for meeting the utility planning requirements.

Though GMA plans are not required in all parts of the state, local land-use plans of one form or another are prepared in all jurisdictions. Local land-use planning, whether done under GMA or outside GMA, could provide an opportunity to evaluate the need and potential for water storage.

Permits for Storage

Regulatory review and approval of water storage facilities usually involve multiple state and federal permits. A summary of some of the major permits and approvals that may be required for a storage project is provided below.

Environmental Review

Water storage projects that require local, state or federal approval require environmental review under the State Environmental Policy Act (SEPA) and/or the federal National Environmental Policy Act (NEPA). Environmental review is not a permit per se, but is intended to ensure that environmental values are considered during decision-making by government agencies. This review involves identifying and evaluating probable effects for all elements of the environment. Many water-storage projects will likely require the preparation of an environmental impact statement (EIS). When a project requires both a state and a federal EIS, the lead agencies can decide to prepare a single document to meet both state and federal requirements.

JARPA Permits

Numerous permits may be required for any water storage projects that involve working in or near state waters. These permits are typically applied for through the Joint Aquatic Resource Permits Application (JARPA). JARPA can be used to apply for the water-related permits shown in Table 3.

Fish and Wildlife Mitigation Policy

The Washington Department of Fish and Wildlife (DFW) has a formal policy related to mitigation that is applicable to proposed water storage projects. The policy is applied by DFW when issuing or commenting on environmental permits. The stated goal of the policy is to achieve no loss of habitat function and value. The hierarchy or continuum of preferred actions is (1) avoiding damage, (2) minimizing damage, (3) repairing damage, (4) reducing damage through long-term maintenance, (5) compensating damage by replacing resources and (6) taking corrective measures over the long-term. It lists the guiding principles for making decisions on appropriate mitigation activities, required elements of mitigation plans and appropriate legal documentation. A complete copy of the policy is in Appendix E.

Table 3: Typical Permits Covered under JARPA Related to Water Storage

Permit	Purpose	Trigger/Activity	Responsible Agency
Hydraulic Project Approval (HPA)	To provide protection for all fish life.	Work that uses, diverts, obstructs, or changes the natural flow or bed of state waters.	Department of Fish and Wildlife, Habitat Program
Water Quality Certification (401)	To ensure that federally permitted activities comply with the federal Clean Water Act, state water quality laws and any other state aquatic protection requirements.	Applying for a federal license or permit for any activity that could cause a discharge of dredge or fill material into water or wetlands, or excavation in water or wetlands.	Department of Ecology, Shorelands & Environmental Assistance Program
Coastal Zone Management Certification (CZM)	To assure compliance with state and Federal Clean Water Act, SEPA, Shoreline Management Act & Energy Facility Site Evaluation Criteria	Conducting projects authorized by the federal agencies and/or applying for certain federal permits or funding.	The federal permitting agency or Ecology Headquarters, Shorelands & Environmental Assistance Program
U.S. Army Corps of Engineers 404 Individual Permits: Discharge of Dredge and Fill Material	To restore and maintain the chemical, physical, and biological integrity of the nation's waters.	Placing a structure, excavating or discharging dredged or fill material in waters of the U.S., including wetlands.	U.S. Army Corps of Engineers
U.S. Army Corps of Engineers Section 10 of the Rivers & Harbors Act, Individual Permit: Work in Navigable Waters	Prohibits the obstruction or alteration of the navigable waters of the U.S. without a permit from the Corps of Engineers.	Placing structures and discharging material in navigable waters of the U.S., including wetlands.	U.S. Army Corps of Engineers
Shoreline Substantial Development Permit	To provide public involvement in the permit process and to foster appropriate uses and protection of the shorelines of the state.	Interfering with normal public use of the water/shorelines of the state, or developing or conducting an activity valued at $2,500 or more on the water or shoreline area.	Local Government (City or County)

State Water Rights/Reservoir Permits

Under Washington Water Code, there are three possible authorizations required for surface-water storage projects.

1. A water right permit or certificate is required to divert or withdraw water to an off-stream reservoir. On-stream reservoirs do not require this authority.

2. A reservoir permit or certificate is required to impound and store water if the reservoir is storing more than 10 acre-feet in volume or if it is 10 or more feet deep at its deepest point.

3. A third permit or certificate that may be necessary is a secondary permit(s) for using reservoir water outside the reservoir.

When practical, the authorizations to divert or withdraw public waters, to store water within a reservoir, and to use stored water outside the reservoir are combined into a single document.

For storing underground water, a water right permit is also required to divert or withdraw water to storage. Under legislation recently passed, the code now allows application for aquifer reservoir permits similar to applying for a surface reservoir permit. The legal need for secondary permit(s) to use reservoir water outside the reservoir is currently under discussion.

Other state laws allow for ground-water storage based upon creating a ground-water management area or sub-area by Ecology, the filing of declarations by a water user claiming to store and withdraw ground water, and confirmation by Ecology. There are several existing rights to store and withdraw ground water established under this process.

There is currently a long wait for processing new water-right applications, resulting in significant uncertainty as to the legal availability of water for storage projects.

Dam Safety Permit

A Dam Safety Construction Permit is required from the Department of Ecology's Dam Safety Office before constructing or modifying any dam or controlling works that can store 10 or more acre-feet of water. This requirement may apply to dams and storage lagoons for: flood control; domestic or irrigation water; domestic, industrial, or agricultural wastes; and mine tailings. Permit processing averages from six to eight weeks, but varies depending on the complexity of the project. Ecology also inspects the construction of all dams to reasonably secure safety of life and property.

Other State Permits

- Department of Natural Resources Forest Practices Permit – A forest practices approval is required of the owner/operator of land and timber before beginning any forest practice, such as harvesting, road construction, etc. Applications are generally processed in five to 30 days (RCW 76.09 and WAC 222).

- Department of Ecology Water Quality Modification – These permits are issued to address turbidity in water during construction, chemical applications in water, or other situations requiring a temporary modification of a water quality standard (RCW 90.48.445 and WAC Chapter 173.201A-110(2)).

Environmental Considerations

When many of the dams and reservoirs were built in Washington state, the environmental effects of these projects were a secondary consideration. Today, many important environmental issues can affect the feasibility and siting of new storage projects. The presence of environmental issues does not automatically preclude the possibility of building a storage project. Some projects may not be "environmentally feasible." For other projects, the presence of significant environmental issues means that additional planning and mitigation will likely be needed, with a concomitant increase in cost and time. Still other water storage projects provide a good opportunity to enhance or restore fish and wildlife habitats.

Environmental considerations for water storage projects will vary by the type of storage (e.g., surface reservoir or aquifer storage) and by the resources that exist at the proposed storage site. Endangered species and the environmental role of flooding are two significant issues that will surface on many storage projects.

Endangered species

The declining status of many salmon species in Washington has resulted in their listing as either endangered or threatened under the federal Endangered Species Act (ESA). The ESA listing could have a significant effect on the state's ability to construct new storage, as well as managing existing storage. There are three major ways in which the ESA may affect existing or new water storage projects.

- First, where a proposed federal action might affect a listed species, the federal agency is required to consult with either the National Marine Fisheries Service (for anadromous fish) or the U.S. Fish and Wildlife Service (for wildlife and non-marine fish) to determine if the action will jeopardize the species. If it does, the action is either prohibited or modified so that jeopardy does not occur.

- Second, to provide protection from ESA sanctions, private landowners, public agencies and others have developed habitat conservation plans (HCPs) that reduce harm to certain listed species while ensuring their long-term protection.

- Third, where actual harm has occurred to a listed species, litigation can be initiated by the federal government or a citizen to enforce the protection requirements of the ESA. For example, an irrigation district in southwest Oregon was forced to remove an irrigation dam to protect a listed fish species.

Endangered species can be a significant challenge for new storage projects. However, if properly designed, storage projects can also provide direct benefits to endangered species.

Environmental Role of Floods

While high flows and flooding can result in significant damage to the human built environment, natural flooding events have shaped many of the features of our watersheds, and they continue to play an important role in sustaining the natural ecosystem functions. A river ecosystem encompasses the river itself, the riparian areas adjacent to it and the substrate below the water. All three are important in providing for healthy fish stocks.

Water temperature, flow in the river and under ground, timing of flow, nutrients, and physical features of the stream channel can affect the ability of the stream to support aquatic life. These features, in turn, are affected and shaped by flooding events. When these events are eliminated, the physical features of the stream can be altered over time and the natural capacity of the stream can be diminished.

Recent advances in the science of river systems have underscored the importance of the natural flow regimen of a river as the template that formed the diversity and abundance of aquatic species. A body of science known as Normative River Concept emphasizes the ecosystem functions of the variability of the natural hydrograph, including the benefits of high spring flows and river floodplain interactions, as well as stable, ample base flows.

Water storage projects that reduce or eliminate natural flooding events in a river system will likely need to address the potential implications to natural functions in the watershed. Analysis and evaluation of these storage projects will likely involve demand curves for each purpose of water needed from the project, including fish.

Operational Considerations

How a water storage project is operated can affect the benefits and consequences of the project.

Using reservoirs for multiple purposes can help spread the benefits (and costs). However, different purposes may need the storage capacity at times that conflict with each other. For example, flood control operation tends to conflict directly with water supply operations, as flood control reservoirs need to be lowered at the time when water supply uses would dictate filling.

Many large hydropower projects have allowed other smaller uses of their water storage reservoirs, under a so-called “good neighbor” policy. However, if these consumptive uses significantly affect power production, the senior and primary uses of the reservoir could assert their right to the water.

Constructing new dams or raising existing dams has public safety implications to downstream residents and property. Raising existing dams will require increased efforts to ensure the safety of these dams. Also, land-use management should be considered below these dams to avoid increasing the risk posed by the dam.

Land-use management is also a consideration for aquifer storage sites. Protecting aquifer storage sites may require actively managing land uses at the storage site to prevent contamination of the stored underground water.

Many reservoirs have a pool of water below the lowest release point on the dam that is typically not used, known as “dead storage.” “Dead storage” is used in some existing reservoirs and could be used in other projects. However, the effects to carryover storage, to other uses of the reservoir, and to habitat may make it unfeasible except for emergencies.

Financing of Water Storage

Funding for water storage has come from several places and varies depending on the purpose of storage. In general, federal dollars have paid for the majority of flood control, irrigation and hydropower storage projects in Washington state. State funding, local government or special purpose districts, and water users have funded the remainder.

For hydropower and irrigation uses, funding for storage projects has mostly come from the public. Federal funds from the U.S. Bureau of Reclamation have paid to construct and operate 58 hydropower plants and 348 reservoirs in 17 western states. The Columbia Basin and Yakima projects, the largest water storage projects in the state, were largely built with these funds. The Yakima enhancement program -- in which the U.S. Bureau of Reclamation , irrigation districts, and Ecology are working together to conserve water, rehabilitate and improve district distribution facilities -- is also primarily funded through federal dollars. Funding from the Corps of Engineers paid for other dams, such as Mud Mountain, Howard Hanson, Wynoochee and several dams on the Columbia and Snake Rivers.

State money has also been used to construct some storage projects in Washington. Referendum 27 was a bond issue in 1972 and provided $25 million dollars for agricultural water supply facilities. All funds were spent. Referendum 38, passed in 1980, provided $50 million for agricultural supply/storage/conservation projects. Rules for Referendum 38 were adopted in 1990 with two phases. Irrigation districts could elect to prepare water conservation plans and then receive state funding for a portion of the capital cost. The Drought Preparedness Account from 1989 provided approximately $12-15 million in loans or grants for short-turn-around drought projects. Funds are available only to public bodies such as irrigation districts and Indian tribes.

Local match funding for the public funds has typically come from the irrigation districts.

For municipal projects, Referendum 38 provided $75 million for public water supplies. However, rate revenue and bonds have been used more recently for storage projects. Storage for fish and wildlife has usually been funded as an add-on to storage projects funded for other purposes.

There is currently no single, clear answer on how new storage projects can be funded. State infrastructure studies have shown the need for water supply projects, but existing sources of public funding are currently oversubscribed. Many storage projects will cost more than a single utility could afford. As a result, coalitions of interests may need to be formed to put together the necessary funding.

Typical Costs

It is difficult to provide precise cost information for "typical" storage projects, because the costs can vary significantly depending on the location, siting, engineering requirements, environmental effects and mitigation, difficulty of construction, and purpose(s) of the project.

However, data on recent projects show that the costs can vary from around $200 per acre-foot of storage for raising existing dams to more than $10,000 per acre-foot for new re-regulation projects with small storage capacity. In general, the cost per acre-foot tends to be higher for small reservoirs and much lower for large reservoirs. Also, projects to construct new dams tend to cost more than raising existing dams. Tables 4 and 5 provide some comparative cost data for selected projects in Washington and other states.

Table 4: Construction Costs for Selected New Reservoirs in Washington and Other States

Project Name	On/Off Channel	Total Cost	Dam Height	Storage	Cost/AF	Purpose/Use
In State						
Zintel Canyon Dam	On	$3.9 million	97 ft.	2300 acre-feet	$1,695	Flood Control
Wenatchee Heights #2 Reservoir	Off	$241,600	30 ft	80 acre-feet	$3,020	Irrigation
Rosa Wasteway 6 Reregulation Res.	Off	$863,000	18 ft	65 acre-feet	$13,280	Irrigation Reregulation
Pine Hollow Reservoir	Off (Proposed)	$50.5 million	185 ft.	24,000 acre-feet	$2,145	Irrigation, Fish
Other States						
Ritschard Reservoir (Colorado)	On	$32 million	122 ft.	66,000 acre-feet	$485	Irrigation, Municipal
Westminister Lake (Colorado)	Off	$3.7 million	31 feet	955 acre-feet	$3,860	Municipal
Eastside Reservoir (California)	Off	$2.1 billion	280 feet	800,000 acre-feet	$2,625	Municipal, Irrigation

Table 5: Construction Costs for Selected Dam & Reservoir Enlargements in Washington

Project Name	On/Off Channel	Total Cost	Dam Raise	Storage Increase	Cost/AF Increase	Purpose/Use
Patterson Lake Dam	Off	$100,000	3 feet	500 acre-feet	$200	Irrigation, Recreation
Keechelus Dam *(Cost to rebuild dam and retain storage instead of permanent drawdown)*	On	$31.9 million	N/A	110,000 acre-feet	$290	Irrigation
Cle Elum Dam (Proposed)	On	$16.7 million	3 feet	14,600 acre-feet	$1,140	In-Stream Flow
Wenas Dam (1982)	On	$3.5 million (Yr. 2000 dollars)	35 ft	2,200 acre-feet	$1,590	Irrigation
Judy Reservoir (Under Construction)	Off .	$9 million	10 ft.	1,700 acre-feet	$5,294	Municipal

Construction Costs for Aquifer Storage and Recovery Projects

The cost of Aquifer Storage and Recovery (ASR) projects is variable and site specific. A systematic assessment of costs for ASR systems has not been published, and the estimates presented are based on limited research of ASR systems nationwide.

Feasibility and pilot testing programs generally range between $100,000 and $500,000 for systems with existing infrastructure. Published annualized unit costs for developed water using ASR range from $30 to $350 per acre-foot ($92 to $920 per million gallons) for systems that do not require new treatment facilities. Costs are significantly higher for systems that require new treatment facilities or other major infrastructure upgrades.

Alternatives to Storing Water

Water storage is one of several water management tools that can provide additional water to meet identified needs. Since the availability and needs for water vary, the use of storage and other tools will differ across the state. Evaluating these tools and decisions on how current and future water needs will be met are best made using a basin-by-basin approach.

Water conservation programs and reclaimed water can provide additional water in many areas. Conservation programs can free up water currently in use and provide new supplies for a relatively small cost. The opportunities for conservation and the costs will depend on how water is currently used in a given area. Reclaimed water is municipal wastewater effluent that is treated to allow use for irrigation or other non-potable purposes. There are significant volumes of waste water that could be reclaimed and put to use, though the costs of treatment and distribution are a significant issue.

In addition to new storage, conservation and re-use, preserving existing natural storage is an important feature for efficient water management. One of the biggest sources of storage is natural groundwater storage, which helps maintain the base flow in streams in the low-flow summer months. Precipitation falling on impervious surfaces such as roads and roofs runs off quickly, resulting in higher winter flows and less infiltration, which reduce natural storage.

Stormwater storage facilities can retain the runoff from urban areas and release it more slowly, which can prevent flooding and erosion. They can also be designed to infiltrate the runoff back into the ground. Small-scale infiltration features can be built into new urban areas, such as leaving more natural vegetation, small-scale infiltration basins, etc. Enhancing snow retention in agricultural areas may also help infiltration.

All these measures could help improve the natural storage in underground water, which will, in turn help, maintain ground-water levels and stream flows during crucial periods of need.

Conclusions

Importance of Water

1. Water is a vital resource for Washington State. Dependable water supplies of sufficient quantity and quality are essential to the economic and environmental health of the state.

Role of Storage

2. Storage can be an important and useful water supply and environmental management tool. Water storage can:
   - Address the needs of all water users.
   - Provide supplies for economic development and population growth.
   - Be used to restore fisheries and help preserve the biological integrity of our watersheds.
   - Enhance recreational activities and provide protection from destructive floods.

3. Members of the Waster Storage Task Force have differing opinions on the relative importance of storage in meeting future water supply needs:
   - Some members believe it is the only tool that will allow the state to meet its future water supply needs in much of the state. These members note that storage is the only method that will produce large enough quantities to meet the identified needs. They also note that storage to produce new supplies will avoid the need to fight over water rights and ownership of existing supplies.
   - Other members believe it will be an important tool in some basins and not in others, and must be used in conjunction with other water supply and demand management options (e.g., conservation, water transfers, and water reuse). These members note that storage options can be very expensive and controversial, and that future needs may be met by water conservation, re-use and marketing of existing supplies in some areas of the state.

Planning For Storage

4. There are many areas in Washington that have abundant, and some times excessive, water during the wet season that could benefit from further evaluation of storage as a tool to meet current and future water needs.

5. The watershed planning process is a significant and timely opportunity for evaluating water storage as a management strategy to meet water needs.

6. Storage projects which are part of an overall plan or agreement among the federal, state, local and tribal governments regarding water management in a basin, and storage projects that serve multiple purposes are most likely to be successfully sited and funded.

7. Different uses of storage may compete with each other by requiring that water be stored or released at different times of year. Optimizing use of storage for one purpose (releasing water from a reservoir to make room for flood control) can hamper the ability to secure other

storage purposes (saving water in a reservoir for later production of hydropower).

8. Planning for new storage projects should consider how to balance the full range of potential uses for the stored water.

Evaluating Storage Projects

9. Because of the complex economic, technical and environmental issues surrounding storage projects, the feasibility of each project must be determined on a case-by-case basis.

10. The potential benefits and impacts of any particular storage project can only be determined by assessment of that particular project and its watershed.

Environmental Considerations

11. If a storage project is to be designed to benefit fish, not just to minimize harm to fish, the design and operation of the project must take into account the variations in timing and flow that support important habitat and crucial ecological functions.

12. Aquifer storage and recovery (ASR) projects, when properly sited and operated, could result in less harm than surface alternatives.

Funding

13. Funding is essential for developing storage projects. Construction costs can vary significantly, with recent project costs ranging from around $100 to more than $10,000 per acre-foot of stored water. New, large storage projects can cost millions of dollars. Planning, design and permitting can also be a significant portion of the total costs. While some public funding is available for select storage uses, the existing public funding programs are severely over-subscribed and would not cover the full cost of a storage project.

14. Funding will need to come from a variety of sources, including a new source of public funds.

Land Use

15. On-site and local practices to manage storm water (e.g., reducing impervious area and providing infiltration basins) will reduce flooding, improve water quality and benefit the water quantity of a basin by preserving the “natural storage” capacity of the land. Storm water that is recharged to the ground will help sustain aquifers and dependent streams during low-flow periods.

Recommendations

Water supply as a state priority

1. Providing adequate water at the right time for diverse needs of the state including people, fish, and agriculture should be a high priority.

Role of the State

2. State agency responsibilities for water storage should be coordinated by Ecology. This would include: providing technical assistance; ensuring effective participation by state agencies; assisting in bringing state, local, tribal, and federal agencies together; and encouraging timely, regulatory review by state agencies. Ecology's coordinating role applies to major projects and planning, not individual projects such as the approval of domestic water storage tanks or other items typically reviewed by Department of Health in water system plans.

Permits and Laws

3. Without compromising environmental review and public involvement, the state should identify and implement efficiencies, to streamline the permitting process of siting and constructing additional water storage projects, reducing the amount of time and overall cost of these projects.

4. The legislature should evaluate existing state laws related to storage to determine if there are gaps or conflicts that need to be addressed.

Planning for Storage

5. Planning for new water storage projects should consider the full range of storage alternatives, including off-channel storage, underground storage, the enlargement or enhancement of existing storage, and on-channel storage; and of both large and small scale (e.g., small stormwater facilities) options.

6. Planning and design for storage should be considered in the context of how water works within an entire basin or watershed. This includes consideration of the natural variability of stream flow and its interaction with the floodplains and associated ground waters, as well as scientific analysis of the water needs of all life stages of the species of interest present in the basin. Planning for storage should also address how storage will integrate with the water supply and delivery system(s) within an entire basin.

7. Water storage infrastructure needs should be inventoried and assessed through watershed planning processes. The inventory should include all public and private water systems. The inventory should ensure that small drinking water systems and fire safety needs are addressed.

8. Consistent with the Watershed Management Act, and other laws, the state should help local watershed planning groups, local governments, utilities, and other stakeholder groups define:
   - The current and future water supply and demand in their watersheds, including in-stream and off-stream needs;
   - The type of storage projects for that watershed; and
   - Potential storage site locations.

9. The Watershed Management Act manual should be updated to add a section on storage. Topics to include are:
   - Different types of storage;
   - Case studies of successful and unsuccessful projects, including aquifer storage and recovery;
   - Recommended procedures for evaluating storage projects; and
   - Recent advances in the science of how a river system supports the diversity of aquatic species, including the latest information on addressing the types of flows that are necessary to provide for key ecological functions of the river system.

10. Groups planning for water storage should be encouraged to include climate fluctuations as it impacts the availability of water as part of the planning processes.

11. The state Dam Safety Office should advise local governments of the status of dams within their jurisdiction so informed local land use decisions can be made.

12. Ecology should work with federal agencies to develop clearer policies and procedures for use of federal lands for water storage projects.

Funding

13. The state needs to pursue creative methods to facilitate the financing of water storage projects, including consideration of: (1) direct appropriation of federal funds; (2) use of salmon recovery funds (federal and state) to help pay for the fish flows and fish features of storage projects; (3) use of state bonding capacity. In addition, some members of the task force suggested consideration of the use of power revenue resulting from changes in flow augmentation programs on the Columbia River mainstem.

14. The legislature should consider establishing funding sources for the design and construction of water storage projects, in consideration of the following:
    - Priority for funding should be provided to projects identified in adopted watershed plans or to projects that are part of an approved HCP or other intergovernmental agreement.
    - The funding should promote a cost-share contribution from those who would directly benefit from the storage.
    - The funding should, at a minimum, cover the costs of storage benefits that would accrue to fish recovery and enhancement and to other general public purposes.
    - Prioritize projects that address multiple needs for water supply and/or flood control.
    - The funding should emphasize small or medium-scaled projects using off-channel or underground storage, or projects that enlarge existing storage sites.

15. When considering infrastructure needs, the legislature should consider water storage projects.

Types Of Storage

16. State and local governments should improve utilization of natural aquifer recharge where practical, by prioritizing measures that control increased runoff.

Role of Storage

17. All task force members agree that properly designed and sited storage is one of several tools available to meet the water supply needs of the state. However, the members have differing recommendations on whether or not storage should be considered in conjunction with other water management tools.
    - Some members recommend that water storage projects be pursued as the primary water management tool in most of the state. These members say that storage is the only method that will generate the quantities required to meet the water supply needs.
    - Other members recommend that water storage be developed in conjunction with water conservation, water reuse, water transfers and water acquisition. These members say that these other water management techniques can extend the life of existing storage facilities and reduce the size and cost of new storage facilities.

Fish Passage

18. Fish passage should be addressed consistent with current laws when developing new water storage dams or when making major modifications to existing water storage dams. When assessing basin needs for storage infrastructure, watershed planning groups should evaluate the need for providing fish passage through existing or future storage projects, including evaluating the water supply needed to operate the fish passage facilities and funding to build the passage structures.

19. All task force members agree that major modifications to existing storage dams will involve an evaluation of the needs and opportunities to provide for fish passage. However, members have differing recommendations on whether passage should be restored on all existing storage dams when they undergo major modifications.
    - Some members recommend that restoring fish passage to existing dams should be pursued where it is economically feasible to build the passage, where the fish benefits will warrant this additional investment for a modification project, and where there are available water supplies to operate the passage facilities.
    - Other members recommend that fish passage on existing dams should, in most cases, be restored as a basic requirement for major modification projects.